微型可调式艾里光束超构器件

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艾里光束因其独特的性质（例如无衍射、自加速和自修复）而引发了广泛的研究兴趣。产生艾里光束的方法一般涉及复杂且昂贵的光学器件，如复杂的光学透镜系统和空间光调制器（SLM）。复杂的光学装置在实现精确对准时难免会遇到困难；SLM 则面临着转换效率低、分辨率有限以及与入射偏振和功率相关的限制等问题。由于采用了笨重的元件，这些技术也难以实现紧凑和集成的光学系统。

香港城市大学的蔡定平教授和哈尔滨工业大学（深圳）的肖淑敏教授联合提出了一种新方法，利用双层全介质超构器件生成可调谐的艾里光束。该方法通过整合和旋转多种精心设计的相位面实现，包括立方相位和两个离轴菲涅尔透镜相位面。通过旋转这两个超表面来动态地操纵艾里光束的轨迹。实验结果与理论预测的艾里光束的强度分布和传播轨迹高度吻合，验证了这一超构器件的可行性和灵活性。

与传统的透镜组系统或空间光调制器相比，所展示的超构器件显著减少了操作复杂性和体积厚度。同时，它可以轻松转移到其他工作波段，而不受偏振或其他方面的限制。它具有小型化、易集成和易控制的优势，能够与其他光学设备兼容，在光镊、激光加工等应用中具有巨大潜力。

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Miniature tunable Airy beam optical meta-device

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The Airy beam has attracted extensive research interest due to its unique properties, such as non-diffraction, self-acceleration, and self-healing. Methods for generating Airy beams generally involve complex and expensive optical devices, such as intricate optical lens systems and spatial light modulators (SLM). SLM faces issues such as low conversion efficiency, limited resolution, incident polarization, and power constraints. Due to the use of bulky components, these technologies also struggle to realize compact and integrated optical systems.

Prof. Dingping Tsai from City University of Hong Kong and Prof. Shumin Xiao from Harbin Institute of Technology (Shenzhen) have presented a new method for producing tunable Airy beams with bilayer all-dielectric metasurfaces. The method involves integrating and rotating carefully designed phase profiles, including cubic and two off-axis Fresnel lens phase profiles. By dynamically manipulating the trajectories of Airy beams through the rotation of these two metasurfaces. These experimental findings align well with the theoretically predicted intensity profiles and propagation dynamics of the Airy beam.

This approach effectively enhances the modulation flexibility of Airy beams without increasing the device footprint. The real-time rotation of metasurfaces, achieved through piezoelectricity, further enhances the tunability and flexibility of these meta-devices. In comparison to conventional tilted cylindrical telescopic systems or SLMs, the demonstrated meta-device significantly reduces volumetric thickness and operational complexity.

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